

# APPENDIX 3

## INTRODUCED NUISANCE SPECIES

## Introduced Aquatic Nuisance Species of Note in the San Francisco Bay-Delta Ecosystem

### BRAZILIAN WATERWEED

Scientific name: *Egeria densa*

Identification: Submerged roots and leaves, partially floating, many-branched shoots up to 3 ft. long. Leaves are linear in shape with pointed tips, up to 1 in. long, without stalks and borne in whorls of 4 to 8 leaves. Male flowers are 3-petaled,  $\frac{3}{4}$  in long, white and borne above water in the summer. This plant can be confused with *Hydrilla*, but *Hydrilla* has a distinctly saw-toothed leaf margin (the finely serrate leaf margin on *Egeria densa* takes a microscope to see).

Problems: Brazilian waterweed is an aggressive competitor often forming dense mats of vegetation that restrict water movement, trap sediment, out compete native vegetation and clog pipes.

Source: As the name implies, this plant is native to Brazil. This plant is a popular aquarium species and probably was introduced from private fish tanks. Shoot fragments can break off and form new patches. Introduced populations of this species are not known to reproduce by seed.

Historic control: Chemical herbicides such as diquat and complexed copper, endothall dipotassium salt, and endothall have shown success.

<http://dbw.ca.gov/aquatic.htm>

### BROADLEAVED PEPPERWEED

Scientific name: *Lepidium latifolium*

Identification: A multi-stemmed herbaceous plant that can reach a height of 3-8 ft. Stems and leaves are dull gray-green in color, glabrous, and coated with a gray waxy substance. Leaves are 1-2 in. wide; 4-12 in. long and have a short leaf stem on young plants. Older plants have stalkless leaves with an alternating arrangement on the stem. Leaf margins may be smooth or have rounded, shallow teeth. Flowers are white, small (0.1 in) and have 4 petals. Many flowers are borne together in upright clusters that are 5-6 in. wide.

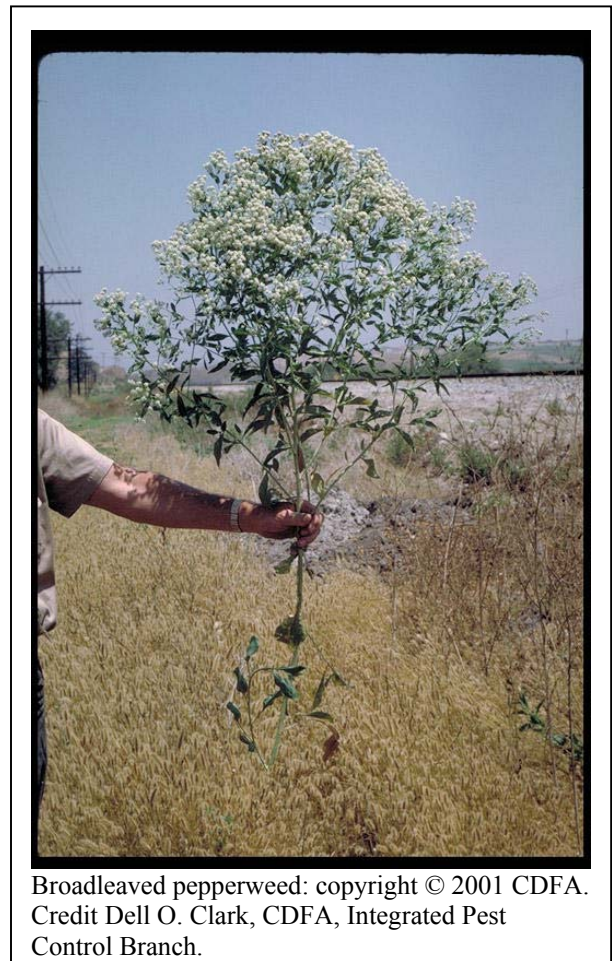
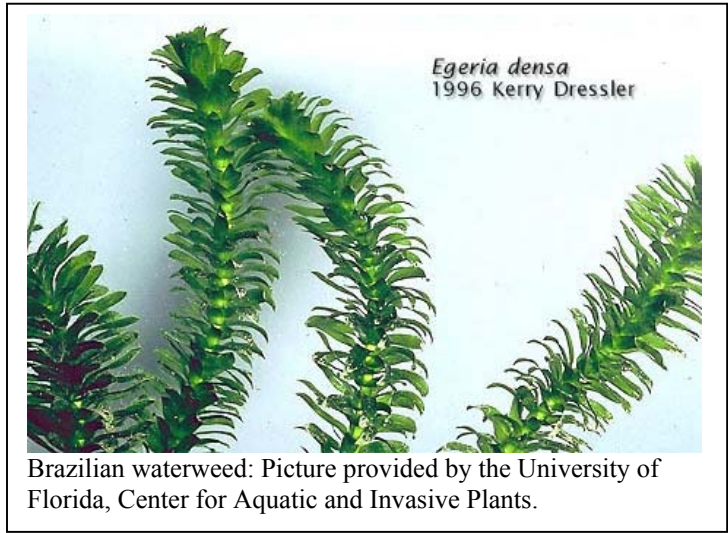
Problems: Pepperweed forms dense monotypic stand along coastal and inland wetlands. It often out competes native grasses that provide food for waterfowl.

Source: Pepperweed has spread from its native range in Eurasia, through uncertain mechanisms. It is possible that seeds or plant parts have been transported with sugar beet seed, rice or straw. Once present spread can occur by seed or pieces of underground-stem.

Historic control: Physical control and chemical herbicides.

<http://tncweeds.ucdavis.edu/moredocs/leplat01.pdf>

[http://ucce.ucdavis.edu/freeform/ceppc/documents/1995\\_Symposium\\_Proceedings1796.PDF](http://ucce.ucdavis.edu/freeform/ceppc/documents/1995_Symposium_Proceedings1796.PDF)



## CANADIAN WATERWEED

**Scientific name:** *Elodea canadensis*, *E. nuttallii*

**Identification:** Roots and leaves are submerged with long, easily fragmented branches reaching 10-12 ft. long. The small (0.25-0.5 in long) leaves curl downward, are translucent dark green, vary from lance shaped to oval and have finely toothed leaf margins. Flowers are green with a purple tinge, 0.4 in. wide, float on the water surface and are borne in summer. This species can be confused with *Egeria densa* and *Hydrilla verticillata*, but *Elodea* can be distinguished by its less dense foliage (leaves are borne in whorls of 3) and green-purple flowers. All three plants are considered to be nuisance species in the Bay-Delta region.

**Problems:** Canadian waterweed is an aggressive non-native plant that can out compete native vegetation and yield uncertain ecological effects. This plant may introduce large quantities of metals (copper, etc.) from streambed sediments into the water.

**Source:** Canadian waterweed is native to Northeastern North America. This species is often grown in ponds and cool water aquariums. It is likely that it was introduced by disposal of cultivated plants. Once present it can spread by stem fragments and occasionally by seed.

**Historic control:** Mechanical control, chemical herbicides, shading, herbivorous aquatic animals.

<http://pi.cdfa.ca.gov/weedinfo/HYDRILLA2.html>



Canadian waterweed: photographed by Kathy Hamel, WA State DOE.

## EURASIAN WATERMILFOIL

**Scientific name:** *Myriophyllum spicatum*

**Identification:** The roots and leaves of Eurasian watermilfoil are usually submerged. Leaves are small (1 in.), variable in color from olive green to reddish and arranged in whorls. Flowers are tiny, white with reddish tinge and borne above the water surface.

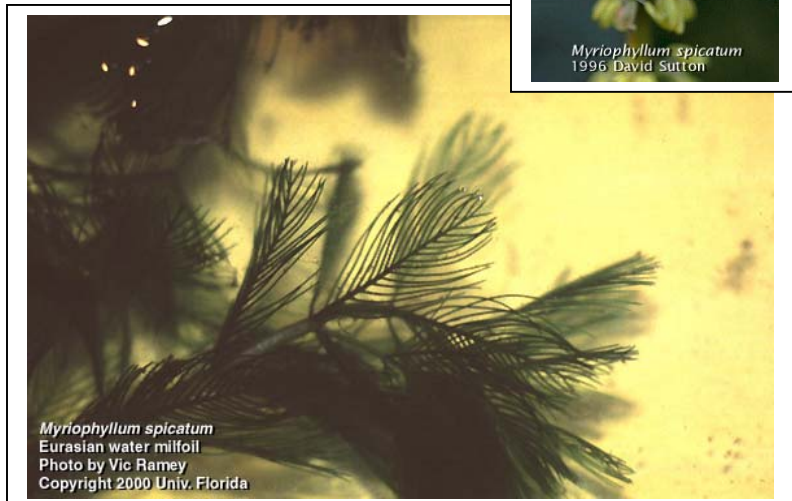
**Problems:** This non-native invader can form dense mats restricting water flow, interfering with recreational water use, reducing fish habitat and altering stream ecology in uncertain ways.

**Source:** As its name implies this plant is native to Eurasia and North Africa. It is unknown how it was introduced into North America.

**Historic control:** Chemical herbicides, benthic barriers, water draw down, shading have shown success. Mechanical harvesting may spread the plant by shoot fragmentation.



*Myriophyllum spicatum*  
1996 David Sutton



*Myriophyllum spicatum*  
Eurasian water milfoil  
Photo by Vic Ramey  
Copyright 2000 Univ. Florida

[http://nas.er.usgs.gov/plants/docs/my\\_spica.html](http://nas.er.usgs.gov/plants/docs/my_spica.html)

## GIANT ARUNDO, GIANT REED

Scientific name: *Arundo donax*

Identification: Giant Arundo is a clump forming grass like plant. It spreads aggressively from underground stems (rhizomes). Individual shoots have thick stems and arching, broad-linear leaves that reach up to 24 in. long. Large spikelets of green to purple flower clusters are produced from spring through fall. Plant clumps, composed of many canes can reach 30 ft. tall and 9 ft. wide.

Problems: Giant Arundo often displaces native vegetation when it forms dense clumps. Its ability to thrive in a wide variety of soil conditions makes it a threat to a wide variety of native plants. Replacement of native riparian plants, with Arundo, can reduce shading of streams and the availability of food sources (insects and high protein seeds) for wildlife. Increased stream water temperatures can put many endangered species at risk.

Source: Giant Arundo is often considered native to warm regions of southern Europe, but may have originated on the Indian sub-continent. This plant is commonly cultivated as an ornamental and probably escaped from this source. Like many grasses, Arundo can spread by rhizomes. This plant is not known to produce viable seeds in North America.

Historic control: Since seeds are not viable, mechanical control has been effective for controlling small populations. Combining mechanical control with chemical herbicides has also been successful.

<http://ceres.ca.gov/tadn/>

## HYDRILLA, WATERTHYME

Scientific name: *Hydrilla verticillata*

Identification: Roots and leaves are submerged; single shoots grow to the water surface and divide into multiple branches. Leaves are small (0.5 in. long), without stems and borne in whorls of 3-8. Flowers have three translucent, whitish petals. This plant can be confused with *Elodea* and *Egeria*. Hydrilla (sparsely foliated) can be differentiated from *Elodea densa* (densely foliated) by the density of leaves. Hydrilla (whitish petals) can be differentiated from *Egeria* (green with purple tinge petals) by flower color.

Problems: Hydrilla is an aggressive, rapid growing plant that can replace valuable native plant species such as pondweeds (*Potamogeton sp.*) and eelgrass (*Vallisneria americana*) potentially impacting native fish populations.

Source: This species is native to warm regions of Asia. Hydrilla can spread by stem fragments or by specialized, underground vegetative propagules (tubers).

Historic control: Mechanical removal, chemical herbicides and some biological control (grass carp).

[http://www.cdfa.ca.gov/phpps/ipc/hydrilla/hydrilla\\_hp.htm](http://www.cdfa.ca.gov/phpps/ipc/hydrilla/hydrilla_hp.htm)



Giant Arundo: source unknown.



Photo credit:  
USGS Colette Jacono

Rainbow River, FL

Hydrilla.

## LUDWIGIA, URAGUAYAN PRIMROSE-WILLOW

Scientific name: *Ludwigia grandiflora*, *Ludwigia uruguayensis*, *Jussiaea michauxiana*, *Ludwigia hexapetala* and others.

Identification: Ludwigia is a horizontally spreading aquatic herb. The horizontal shoots can grow in excess of 2 ft. long and root at the nodes. Leaves are elliptic in shape, 2.5 in. long, medium green and occasionally have spongy roots attached. Flowers are yellow, 2 in. across, and have dark yellow spots at the bases of petals.

Problems: Ludwigia forms dense monotypic mats that reduce fish habitat, interfere with recreational use and have uncertain effects on stream ecology.

Source: Ludwigia is native to tropical regions of South America and some believe it may also be a native of North America. Once present it can reproduce and spread in still or slow flowing waters by seeds and by vegetative root sprouts.

Historic control: Unknown.



Ludwigia: provided by Fossé Réserve Naturelle de Bruges (Gironde).

## PARROT FEATHER, WATERMILFOIL

Scientific name: *Myriophyllum aquaticum*

Identification: Roots are usually submerged with un-branched stems growing to 6 ft. long and protruding from the water. Leaves are yellowish-green, 1.5 in. long, are feathery looking and borne in whorls of 4 or 5. New leaves are shorter and bluish green. Flowers are tiny, yellow and borne in spikes from leaf axils.

Problems: In other countries such as Japan and South Africa, it has been known to clog rivers and other waterways. It can also potentially displace native plant species and have uncertain impacts on local ecosystems.

Source: Parrot feather is native to Java, Australia, New Zealand and South America. This plant has been used for tropical aquariums and may have escaped from cultivation. Parrot feather spreads rapidly from stem fragments.

Historic control: Chemical herbicides, mechanical control can result in further spread by stem fragments.

<http://www.anr.state.vt.us/dec/waterq/ans/objects%5Cpffs.pdf>



Parrot feather.

## PURPLE LOOSESTRIFE

Scientific name: *Lythrum salicaria*

Identification: Clump forming with stiff, branched stems that grow upright. Leaves are lance shaped, sparsely hairy and 4 in. long. Leaves are arranged in pairs opposite each other, alternating at right angles from the last pair down the stem. Flowers are red or reddish-purple, small (0.75 in) and borne in upright spikes beginning in the summer.

Problems: Purple loosestrife is an aggressive plant that can easily out compete native shore plants. It replaces valuable habitat for waterfowl with inedible, dense stands of unsuitable nesting sites.

Source: Purple loosestrife is native to temperate regions of Europe and Asia. It was probably introduced to California as

an ornamental plant and has escaped from cultivation. It may have introduced to other parts of North America in solid ballast from Europe. Most states still allow the legal sale of this species, but its sale is prohibited in Minnesota, Wisconsin, Washington and Illinois. Once established purple loosestrife can spread by seed and from root fragments.

Historic control: Mechanical removal has been effective before seed set. Chemical herbicides and to a limited extent biological control (insects) have also been used to control established populations of this species.

[http://www.cdfa.ca.gov/phpps/ipc/purpleloosestrife/purpleloosestrife\\_hp.htm](http://www.cdfa.ca.gov/phpps/ipc/purpleloosestrife/purpleloosestrife_hp.htm)



Purple loosestrife: provided by The Nature Conservancy, Wildland Invasive Species Team.

## SCARLET WISTERIA

Scientific name: *Sesbania punicea*

Identification: Scarlet wisteria grows as a large shrub or small tree, maturing at over 12 ft. tall. It has long (8-12 in.), leaves with many (6-20 pairs) of leaflets. Flowers are reddish-purple, small (0.75 in.) and borne in 4 in. long clusters. Both the flowers and seedpods resemble those of pea plants.

Problems: This aggressive competitor can form dense thickets, eliminating native plant communities. The seeds are buoyant and can spread large distances with flowing water.

Source: Scarlet wisteria is native to South America. It is a prolific seed producer and can spread quickly into a variety of environments. It is likely that this species has nitrogen fixing root nodules, like most members of the Pea family, and can thrive in low nutrient soils.

Historic control: Mechanical control has been successful with young plants. A combination of mechanical control and application of chemical herbicides have been used for larger plants. In South Africa biological control agents have been used to control this species with uncertain success.

<http://tncweeds.ucdavis.edu/alert/alrtsesb.html>



Scarlet wisteria: provided by The Nature Conservancy, Wildland Invasive Species Team.

## TAMARISK, SALT CEDAR

**Scientific name:** *Tamarix spp.*

**Identification:** Tamarisk can grow as an arching shrub or as a small tree that matures at over 30 ft. tall. Leaves are very small (0.1 in. long), pointed, crowded on the gray-green stems and range in color from gray-green to reddish-brown. Flowers are pink, tiny and packed into dense flower clusters, over 3 in. in length, on the tips of new shoots. The bark of Tamarisk is reddish brown and will develop furrows and ridges on mature trees.

**Problems:** Tamarisk is very drought tolerant and well adapted to a variety of conditions and can out compete many native species. This plant is named for its ability to secrete salt from its leaves and stems. The high soil salt content resulting from these secretions inhibits the growth of most native plants anywhere near a mature Tamarisk tree. Seeds are low in protein and this plant does not provide adequate forage for native wildlife. Tamarisk can also deplete ground water, by consuming up to 200 gallons of water a day!

**Source:** Tamarisk is native to a wide region from North Africa through Europe and Asia. It was originally introduced to North America as an ornamental and has probably escaped from cultivation. Seeds are a source of new plants and prefer to germinate in saline water (up to 15 ppt). **Historic control:** Chemical herbicides, stem cutting combined with herbicide application and prolonged water inundation have been successful. Mechanical removal has been less successful due to the ability of saltcedar to re-sprout from roots.

<http://www.ca.blm.gov/bishop/saltcedar.html>



Saltcedar: provided by Angela Barranco: Columbia University, NY, NY.

## WATER HYACINTH

**Scientific name:** *Eichornia crassipes*

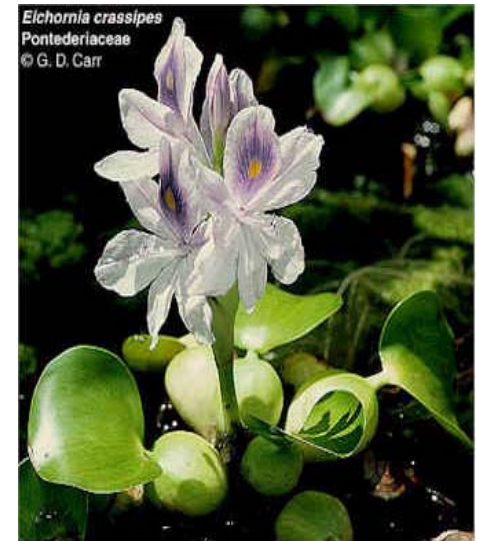
**Identification:** This floating or anchored aquatic plant has thick, hollow stems that allow it to float. Leaves are rounded to oval in shape, up to 6 in. across and a light green color. Long greenish-purple roots hang down into the water during flowering, often over 12 in. in length. Flowers are 1.3 in. across and range in color from pale blue to violet, with yellow spots on the top of petals. Flowers are borne in 6 in. long upright spike, above the water.

**Problems:** Water hyacinth is so successful at reproduction that it can clog entire lakes or slow moving rivers. Surface coverage by this species will shade out many aquatic natives and may reduce food sources for aquatic animals. In some areas this species has been a cause of flooding, clogging water diversions and pumps as well as interfering with commercial and recreational water navigation. Water hyacinth can also increase sedimentation, and lower dissolved oxygen content in the water with subsequent effects on commercial and sport fish.

**Source:** Water hyacinth is native to tropical regions of South America. It was probably introduced as a discarded ornamental pond plant. Plants can spread asexually when parts of the stem break off from the mother plant as well as by seeds (which can remain viable for at least 20 years).

**Historic control:** Very small infestations have been controlled by mechanical removal. Chemical herbicides can be difficult to control when released into water bodies. Several biological control agents have shown some success including 2 beetles, a moth and a fungus.

<http://dbw.ca.gov/aquatic.htm>



Water hyacinth: provided by Pacific Island Ecosystems at Risk (PIER).

## YELLOW FLAG IRIS

**Scientific name:** *Iris pseudacorus*

**Identification:** Yellow flag iris is a vigorous growing clump forming herb, which can reach a height of up to 5 ft. Leaves originate in a rosette at the base of the plant, are lance shaped, gray-green and have ribs running lengthwise. Flowers in groups of 4-12 are borne on branched stems that originate at the plant base. Flower petals are brilliant yellow with brown or violet markings and ruffled in appearance.

**Problems:** Yellow flag iris is an aggressive species that can form large clumps in and around shallow water bodies. These clumps can trap sediment and clog waterways. Dense populations of yellow flag iris can reduce fish habitat and interfere with navigation of waterways. This species is poisonous and cannot be utilized by grazing animals.

**Source:** Yellow flag iris originates in a wide geographical range from Europe to Western Siberia and North Africa. It was probably introduced to eastern North America as an ornamental plant that has subsequently escaped from cultivation. This species mainly spreads by underground stems and by gardener's who may not know of its invasive potential, but the seeds can also be viable.

**Historic control:** Mechanical removal or cutting stems and painting with chemical herbicides has been used to control this species.

<http://aquat1.ifas.ufl.edu/seagrant/iripse2.html>



Yellow flag  
*Iris pseudacorus*  
Photo by Vic Ramey  
Copyright 2001 Univ. Florida

## ASIAN CLAM (FRESHWATER)

**Scientific name:** *Corbicula fluminea*

**Identification:** Asian clams vary in appearance, partially due to the environment, and can be difficult to identify. Individual clams may grow to 1 in long and are light brown in color. Distinctive features are the concentric curved ridges and fine serration on the anterior and posterior edges of the shell.

**Problems:** The prolific reproduction of this filter feeding species implies that they may have a major impact on native food webs and deplete food sources used by native bivalves. It has also yielded adverse economic impacts by fouling water supplies for irrigation, drinking water and industrial uses.

**Source:** Asian clams are native to temperate and tropical regions of China, Korea and southeastern Russia. They may have been introduced to the bay-delta in ballast water. Asian clams are prolific reproducers and produce the most offspring in the fall.

**Historic control:** Mechanical removal and molluscicides have historically been used to control Asian clams.



Asian clam: picture provided by USGS.

## CHINESE MITTEN CRAB

Scientific name: *Eriocheir sinensis*

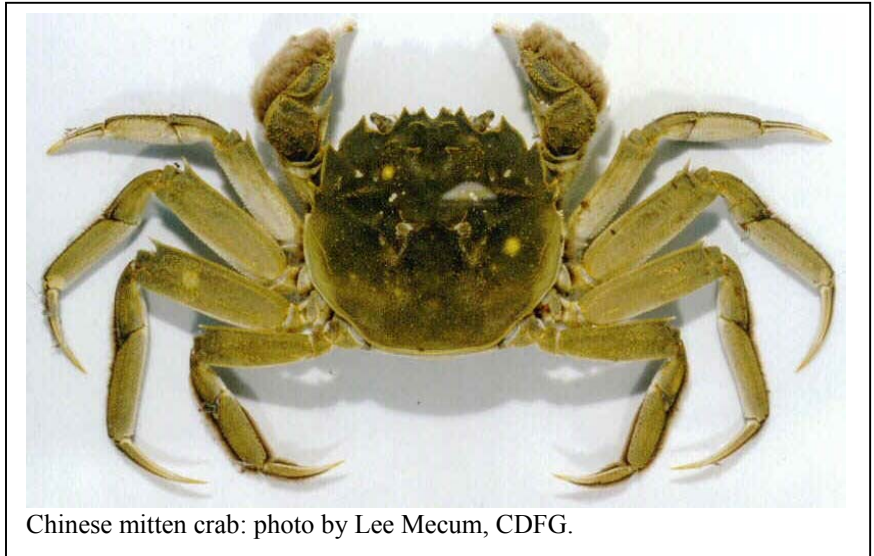
Identification: The dense patches of hair and white tips on their claws can easily identify Chinese mitten crabs, however regenerated claws may not be hairy. Both front claws are equal in size. The crab's body is slightly wider than long and has 4 distinct spines on the front lateral portion of its exoskeleton. Mature individuals typically reach over 3 in. in carapace width, but larger ones have been found.

Problems: It is uncertain what consequences will result from the introduction of Chinese mitten crabs to the bay-delta region. In other areas where the species has been introduced population sizes have exploded. Chinese mitten crabs may pose an economic threat to fishing nets and commercially harvested species, endangered fish salvage operations, agricultural crops and stream bank stability. The Chinese mitten crab is also thought to be capable of transmitting a lung fluke that can infect and potentially kill humans.

Source: Chinese mitten crabs are native to coastal regions of Asia. It is uncertain how they arrived in the bay-delta region, but they may have been introduced in ballast water or intentionally to establish a commercial fishery. The first known populations of Chinese mitten crabs were identified in the bay-delta in the 1990's. In other regions Chinese mitten crabs have reproduced so prolifically as to be a serious nuisance.

Historic control: Control methods are still in the experimental stages, but some success has been achieved with streambed diversions to traps.

<http://www.delta.dfg.ca.gov/mittencrab/>



Chinese mitten crab: photo by Lee Mecum, CDFG.

## ZEBRA MUSSEL – No populations currently present in CA, but the potential for introduction exists!

Scientific name: *Dreissena polymorpha*

Identification: Zebra mussels can reach a length of up to 2 in. and have an asymmetrical triangular shaped shell. A series of concentric ridges follow the outermost curve of the shell as the bivalve grows. Many shells have the characteristic stripped pattern seen in the picture on the right, but some do not. Shells can be solid light or dark colors, stripped or any variation in between. Unlike native bivalves, zebra mussels are often found in clumps.

Problems: Zebra mussels are so good at filtering water that they deprive the water of nutrients effectively starving native bivalves and concentrating pollutants in birds and other organisms that feed on them. Massive economic costs have been incurred due to fouling of ships, water pipes and other aquatic infrastructure.

Source: Zebra mussels are native to fresh waters of Europe and may have been introduced to North America in ship ballast water or as ship fouling, from the north shore of the black sea. This species cannot survive in ocean water, but may be able to survive in estuaries containing a mixture of fresh and salt water. They are prolific reproducers and quickly populate areas that can support them.

Historic control: Mechanical removal does little to control the spread of this species. Molluscicides, heated water, desiccation and ultraviolet light have been used to control the species in limited circumstances. Feeding by waterfowl may help to control the population in areas where the water bodies do not freeze seasonally.

[http://nas.er.usgs.gov/zebra.mussel/docs/sp\\_account.html](http://nas.er.usgs.gov/zebra.mussel/docs/sp_account.html)



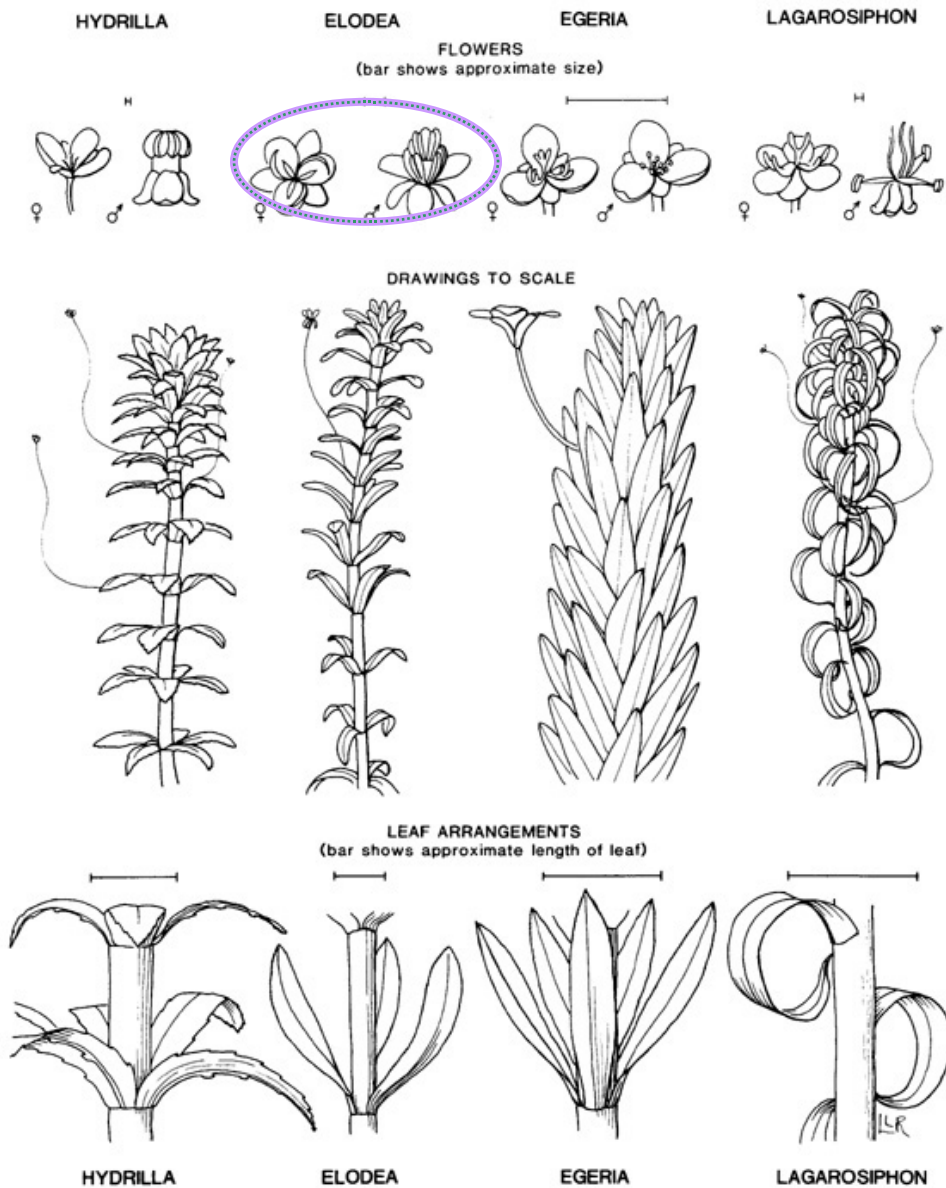
Picture provided by USGS.

## Key to Differentiating *Egeria densa*, *Hydrilla verticillata* and *Elodea canadensis*

-*Egeria densa* (BRAZILIAN WATERWEED) has dense whorled foliage, with a finely serrate leaf margin and small white flowers.

-*Hydrilla verticillata* (HYDRILLA, WATERTHyme) has sparse foliage, coarse saw-toothed leaf margins and small white flowers.

-*Elodea canadensis* (CANADIAN WATERWEED) has sparse foliage, finely serrate leaf margin and greenish-purple flowers.



## **Useful Websites**

InvasiveSpecies.gov

<http://www.invasivespecies.gov/profiles/main.shtml>

Aquatic Nuisance Species Taskforce

<http://www.anstaskforce.gov/>

US Geological Survey Nonindigenous Aquatic Species Information Resource

<http://nas.er.usgs.gov/>

California Department of Food and Agriculture: Encycloweedia

<http://pi.cdfa.ca.gov/weedinfo/Index.html>

California Exotic Pest Plant Council

<http://www.caleppc.org/>

Natural Resources Conservation Service, USDA

<http://plants.usda.gov>

Practical Guidebook to the Control of Invasive Aquatic and Wetland Plants of the San Francisco Bay-Delta Region

<http://www.sfei.org/nis/index.html>

The Nature Conservancy, Weeds on the Web

<http://tncweeds.ucdavis.edu/>

USDA, Natural Resources Conservation Service, Wetland Science Institute

<http://www.pwrc.usgs.gov/WLI/wris1.htm>

University of Florida, Line drawings of aquatic plants

<http://aquat1.ifas.ufl.edu/drawlist.html>

Washington State Department of Ecology

<http://www.ecy.wa.gov/programs/wq/links/plants.html>